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(71) Applicants *(for all designated States except US)*: **UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY** [GB/GB]; Sackville Street, P.O. Box 88, Manchester, Lancashire M60 1QD (GB). **COOKE, William** [GB/GB]; 9 Howey Hill, Congleton, Cheshire CW12 4AA (GB). **FERNANDO, Anura** [LK/GB]; 12 Heatherside, St Paul's Garden, Stalybridge, Cheshire SK15 2QN (GB). **JAYAWARNA, Dimuth** [LK/GB]; 4 Ridgecroft, Limehurst Estate, Ashton under Lyne, Lancashire OL7 9TG (GB). **CHAUDHURY, Najmal, Hassan** [GB/GB]; 14 Alston Avenue, Sale, Cheshire M33 4AS (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **DIAS, Tilak** [GB/GB]; 6 Briar Hollow, Heaton Mersey, Stockport, Cheshire SK4 2EE (GB).

(74) Agents: **COLLINGWOOD, Anthony, Robert** et al.; Lloyd Wise, McNeight & Lawrence, Regent House, Heaton Lane, Stockport, Cheshire SK4 1BS (GB).

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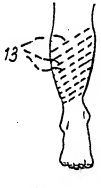
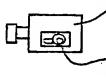
(54) Title: PRESSURE GARMENT





(57) Abstract: There is disclosed a method for making a pressure garment, comprising the steps of: defining 3D shape and pressure profile and characteristics of a garment; specifying a knitting pattern for the garment; calculating yarn feed data for the knitting pattern to produce the defined shape and pressure profile and characteristics; and knitting the seamed or seamless garment according to the knitting pattern and the yarn feed data.

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Pressure Garment

This invention relates to pressure garments and methods for making them. By the term "pressure garments" is meant garments which apply pressure to specific areas of the human or animal body for medical reasons, such as the management or treatment of venous ulceration, deep vein thrombosis or burns, or for operational reasons such as in G-suits or sportswear.

Conventionally, pressure garments are made as simple structures such as support hose, where the requirement is expressed as being simply to apply a level of pressure which is adequate but not too much, and this is achieved by experience or by trial and error. Of course, a given size of support hose will stretch more on patients with heavier build than on those of slight build, and since the degree of pressure exerted depends on the degree of stretch, a heavier built patient will experience more pressure than a lighter built patient, and the notion of 'one size fits all' works out in practice as 'one size fits nobody perfectly'.

G-suits, and in particular space suits, tend to be custom made and are fitted with dynamic pressure control, for example to compress the lower body under high downward gravitational loading in order to prevent drainage of blood from the brain to the lower body. These garments are very expensive.

The present invention provides new methods for making pressure control garments that enable custom designed garments to be made quickly and accurately to give medically-prescribed pressure regimes.

The invention comprises a method for making a pressure garment, comprising the steps of:

- defining shape and pressure characteristics of a garment;
- specifying a knitting pattern for the garment;
- calculating yarn feed data for the knitting pattern to produce the defined shape and pressure characteristics; and
- knitting the garment according to the knitting pattern and the yarn feed data.

The shape characteristics may be defined by way of generating a plurality of discrete points (a "point cloud") which define the body or part thereof for which the garment is intended.

In one embodiment, the shape characteristics are defined with reference to data derived from scanning the body or part thereof for which the garment is intended.

In another embodiment, the shape characteristics are defined using CAD images of input data. The input data may be, for example, measurements made of the body or part thereof for which the garment is intended.

In another embodiment still, the shape characteristics are defined with reference to a plurality of two dimensional images of the body or part thereof for which the garment is intended. Typically, a plurality of images from different angles and/or elevations may be used. A point cloud may be generated from the plurality of two dimensional images, the point cloud being used for subsequent processing such as by a CAD system.

The pressure profiles and characteristics may be defined from medical considerations - a medically qualified person may, for example, decide to prescribe that a certain pressure be applied over a certain area, and may operate a 3D body scanner, which may be of a commercially available type, or which may be specially developed for this purpose, to define the 3D shape and dimensions of the garment, and scanned data that may be in the form of a point cloud may then be transmitted to a CAD system for defining pressure profiles and characteristics. The CAD system calculates yarn feed data and the knitting pattern. The scanning environment may be remote from the CAD system, data being transmitted by any convenient means such as by e-mail.

CAD system calculated data may be transmitted to a manufacturing operation, which may, again, be remote from the CAD system, data, again, being transmitted by any convenient means.

Point cloud data representing 3D shape characteristics may be processed to generate an image of the 3D shape the garment has to fit, and pressure profiles and characteristics may then be used to calculate machine and/or knitting parameters. The data may be overlaid with simulated needle points of a knitting machine to be used for making the garment. The garment may be knitted on an electronic flat bed knitting machine or a circular knitting machine.

The knitting machine and yarn delivery system may be controlled for the formation of each stitch, tuck or float of the knitting pattern according to the calculated yarn feed data. The garment may be manufactured as a 3D seamless garment.

The elastic extensibility of the knitted garment may be a combination of yarn elongation and deformation of knitted structure in the garment. This may give the

predetermined pressure profile and characteristic on elastic extension, effected by donning the garment.

The garment may be knitted using low modulus yarn, which may be polymer and/or metal yarn having linear and/or non-linear tension/extension characteristics. The yarn may, for example, increase or decrease its modulus of elasticity on elevation of its temperature from ambient or specified temperature to body temperature.

The invention also comprises garments made by the methods of the invention.

The invention also comprises apparatus for making pressure garments comprising data processing means adapted to calculate yarn feed data for a specified knitting pattern based on defined shape and pressure characteristics of a garment, and a knitting machine controlled to knit the garment according to the knitting pattern and the yarn feed data.

The knitting machine may be an electronic flat bed machine or a circular knitting machine.

The knitting machine may be remote from the data processing means, with a data link of some description, for example, e-mail, transmitting the data to the knitting machine.

The apparatus may also include scanning means for deriving 3D shape and dimensions from the human or animal body the garment is intended for. The scanning means may be remote from the data processing means, information about the 3D shape and dimensions together with prescribed pressure profiles and its characteristics being transmitted to the data processing means, again by any suitable link.

Methods for making pressure garments, garments made thereby and apparatus therefor will now be described with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic illustration of a manufacturing system incorporating the various aspects of the invention;

Figure 2 is a view of a scanning arrangement deriving shape characteristics from a leg for which a pressure garment is to be prescribed; and

Figure 3 is a diagrammatic illustration of a yarn feed arrangement of an electronic flat bed knitting machine used in the method of the invention.

The drawings illustrate making a pressure garment comprising the steps of

- defining shape and pressure characteristics of a garment
- specifying a knitting pattern for the garment
- calculating yarn feed data for the knitting pattern to produce the desired shape and pressure characteristics, and
- knitting the garment according to the knitting pattern and the yarn feed data.

The 3D shape and the dimensions are defined in a body scanner environment 11, Figure 1. The part of the body at issue is scanned to determine its shape and dimensions - see Figure 2 (eg leg is being scanned by a commercially available scanner 12).

Pressure profiles and characteristics may be defined on the 3D scanned image. This information is matched with a suitable knitting pattern. In Figure 2, the leg with lines corresponding to course lines in the finished garment which the medical practitioner may colour code (if it is a colour scanner) or make darker or lighter shades to indicate a pressure profile, adding, perhaps, legend denoting what pressure is meant by a certain colour or thickness of marking. The scanner 12 can store its data on, for example, a CD or files server 14, which can be down loaded via any suitable means, e.g. e-mail, intranet or Internet to a CAD system 15 which may be remote from the scanning environment.

On the CAD system 15, the scanned data is used to generate a 3D image of the body part onto which the medical practitioner may map the required pressure profiles. The 3D shape data can be used to produce a screen image, for example, of the required garment, which may be a 2D or 3D image, and overlie it with simulated needle points of the knitting machine for which the pattern is intended. The yarn feed for each stitch, tuck or float of the pattern may be calculated by a suitable algorithm to produce the required pressure profiles and characteristics.

The knitting pattern, in the form, now, of instructions to control the knitting machine, together with the yarn feed data, and together with the patient data, machine data, yarn data and any other relevant information is transmitted to a manufacturing facility 16 and loaded into a flat bed knitting machine controller 17, Figure 3.

Figure 3 illustrates diagrammatically a flat bed knitting machine 18 with a needle bed 19 and a rail 21 along which runs a yarn feeder 22 which has yarn feed wheels 23 controlled by a precision servo motor 26 together with a pneumatic yarn reservoir fed by yarn feed wheels 24 in which a loop of yarn 25 is held available for rapidly varying feeding rates to the needles at various stages of the knitting so as to put precisely the right

amount of yarn into each stitch, tuck or float. The pneumatic reservoir is to hold the yarn under near zero uniform tension - the yarns used in the manufacture of pressure garments are elastomeric, tension-sensitive yarns.

Special yarns, of polymer and/or metal, which have linear or non-linear tension/extension characteristics, may be used in the manufacture of pressure garments according to the invention.

CLAIMS

1 A method for making a pressure garment, comprising the steps of:

- defining 3D shape and pressure profile and characteristics of a garment;
- specifying a knitting pattern for the garment;
- calculating yarn feed data for the knitting pattern to produce the defined shape and pressure profile and characteristics; and
- knitting the seamed or seamless garment according to the knitting pattern and the yarn feed data.

2 A method according to claim 1, in which the 3D shape and dimensions are defined with reference to data derived from scanning the body or part thereof for which the garment is intended.

3 A method according to claim 1 or claim 2, in which the pressure characteristics are defined by medical considerations.

4 A method according to any one of claims 1 to 3, in which the shape and pressure profile or characteristics are defined in a CAD system for calculating yarn feed data and for a selection of a knitting pattern.

5 A method according to claim 4, in which the scanning environment is remote from the CAD system.

6 A method according to any one of claims 1 to 5, in which the CAD system-calculated yarn feed data and the knitting patterns are transmitted to a manufacturing operation.

7 A method according to claim 6, in which the manufacturing operation is remote from the CAD system.

8 A method according to any one of claims 1 to 7, in which point cloud data representing shape and dimensions are processed to generate an image of the shape and dimensions the garment has to fit, and pressure characteristics are used to calculate machine and/or knitting parameters.

9 A method according to claim 8, in which the data are used to calculate the number of needles per course for knitting the garment.

10 A method according to any one of claims 1 to 9, in which the garment is knitted on a flat bed knitting machine.

11 A method according to any one of claims 1 to 10, in which a servo motor controlled feed system is controlled for the formation of each stitch, tuck or float of the knitting pattern according to the yarn feed data.

12 A method according to any one of claims 1 to 11, in which the garment is manufactured as a 3D seamless garment.

13 A method according to any one of claims 1 to 12, in which the elastic extensibility of the garment is controlled by a predetermined combination of yarn

elongations and deformation of the knitted structure in the garment to give a predetermined pressure profile due to the elastic extension effected by donning the garment.

14 A method according to any one of claims 1 to 13, in which the garment is knitted using low modulus yarn.

15 A method according to any one of claims 1 to 14, in which the garment is knitted using polymer and/or metal yarn having linear or non-linear tension/extension characteristics.

16 A method according to claim 15, in which said yarn increases in modulus of elasticity on elevation of temperature from ambient to body temperature.

17 A pressure garment made by a method according to any one of claims 1 to 16.

18 Apparatus for making pressure garments comprising data processing means adapted to calculate yarn feed data for a specified knitting pattern based on defined 3D shape and pressure profiles and pressure characteristics of a garment, and a knitting machine and a yarn delivery system controlled to knit the garment according to the knitting pattern and the yarn feed data.

19 Apparatus according to claim 18, in which the knitting machine is a flat bed machine.

20 Apparatus according to claim 18 or claim 19, in which the knitting machine is remote from the data processing means, with a data link of some description, for example, e-mail, transmitting the data to the knitting machine.

21 Apparatus according to any one of claims 18 to 20, also including scanning means for deriving shape characteristics from the human or animal body the garment is intended for.

22 Apparatus according to claim 21, in which the scanning means are remote from the data processing means, information about the shape characteristics together with prescribed pressure profile and characteristics being transmitted to the data processing means by any suitable link.

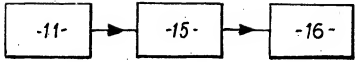

FIG. 1

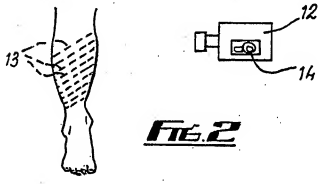

FIG. 2

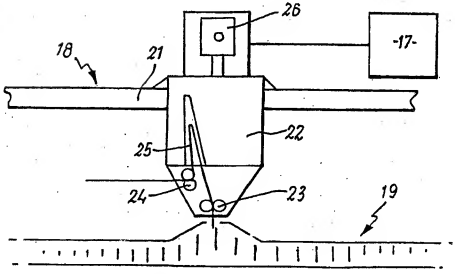

FIG. 3

INTERNATIONAL SEARCH REPORT

Internati Application No
PCT/GB 02/04909

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D04B37/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	column 4, line 57-61	10,19
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2003	24/02/2003
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Sterle, D

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